Working memory and retrieval practice

- Define working memory
- Examine how to use retrieval practice to maximise working memory
- Reflexively plan for how you can maximise the working memory of those you teach

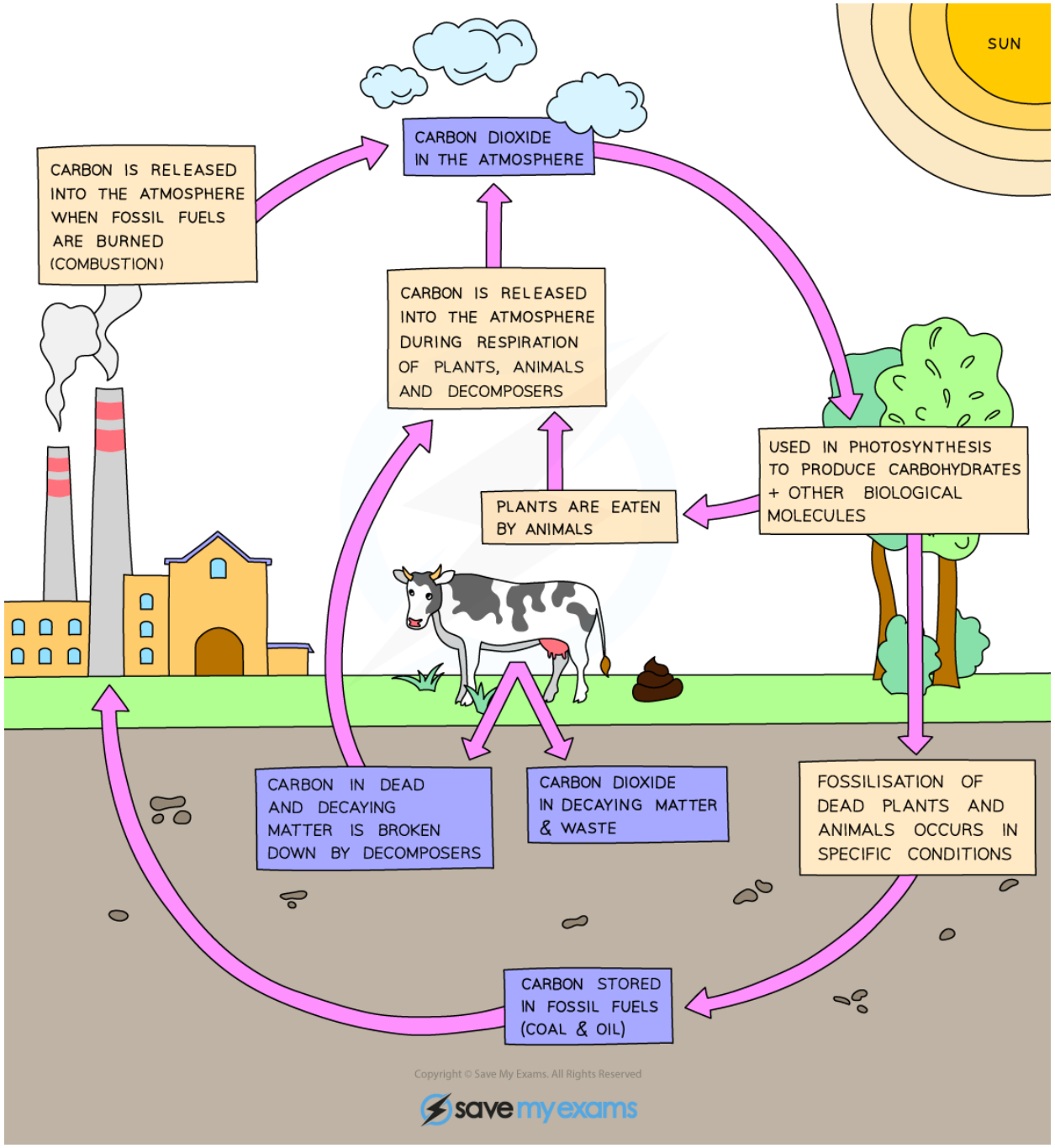
ITTECF link

How pupils learn – standard 2 – promoting good progress

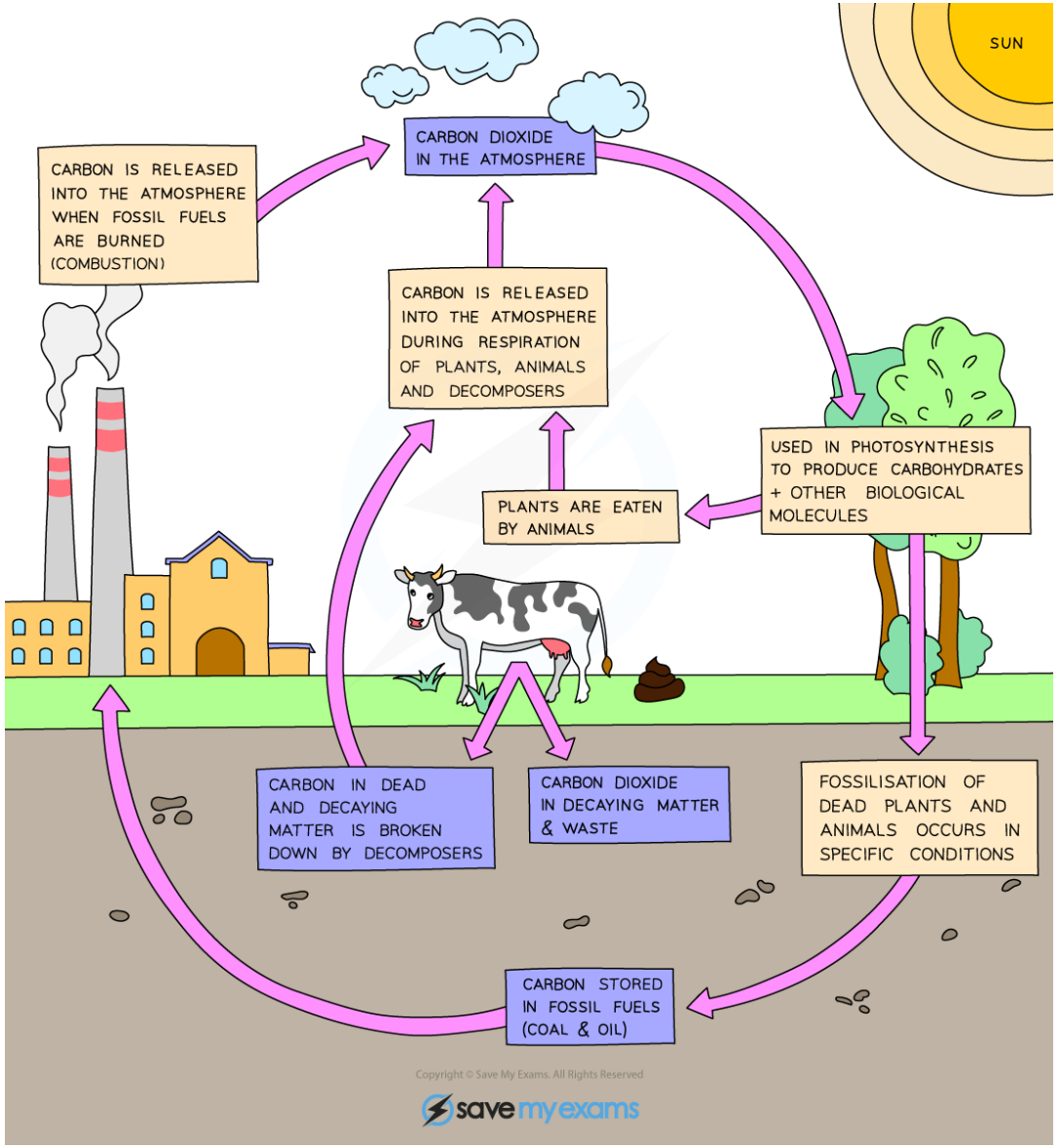
“An important factor in learning is memory, which can be thought of as comprising two elements: working memory and long-term memory. Working memory is where information that is being actively processed is held, but its capacity is limited and can be overloaded.

Pupils have different working memory capacities; some pupils with SEND may have more limited working memory capacity than their peers without SEND.”

Initial Teacher Training and Early Career Framework


SUN
CARBON DIOXIDE IN THE ATMOSPHERE
CARBON IS RELEASED INTO THE ATMOSPHERE WHEN FOSSIL FUELS ARE BURNED (COMBUSTION)
CARBON IS RELEASED INTO THE ATMOSPHERE DURING RESPIRATION OF PLANTS, ANIMALS AND DECOMPOSERS
USED IN PHOTOSYNTHESIS TO PRODUCE CARBOHYDRATES + OTHER BIOLOGICAL MOLECULES
PLANTS ARE EATEN BY ANIMALS
CARBON IN DEAD AND DECAYING MATTER IS BROKEN DOWN BY DECOMPOSERS
CARBON DIOXIDE IN DECAYING MATTER & WASTE
FOSSILISATION OF DEAD PLANTS AND ANIMALS OCCURS IN SPECIFIC CONDITIONS
CARBON STORED IN FOSSIL FUELS (COAL & OIL)
Copyright © Save My Exams. All Rights Reserved
savemyexams

What insights did this task give to you about the limits and strengths of working memory? How might this inform your teaching practice?



Core principles

- **Learning is change in capability.** Learning involves developing lasting changes in pupils' understanding or abilities.
- **Role of prior knowledge.** Strong prior knowledge, securely stored in long-term memory, supports the learning of more complex ideas and reduces misunderstanding.
- **Memory types.** There are two key memory types - working memory (short-term, actively processed, limited capacity) and long-term memory (knowledge store amplified with new learning).

In science lessons

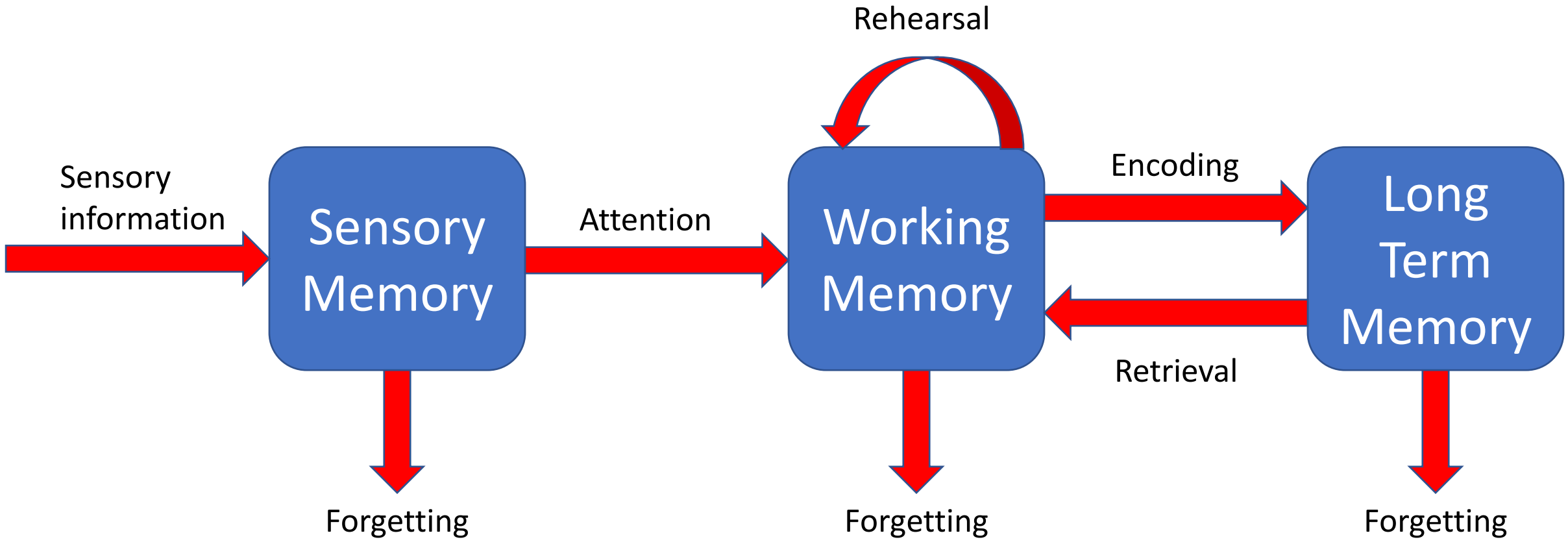
- **Capacity is limited.** Memory can easily be overloaded, especially with complex concepts or too much new information at once.
- **Differentiation matters.** Pupils vary in their working memory capacity; those with SEND may be particularly affected.
- Support through **instructional design**:
  - Break down material into small, manageable steps.
  - Use partially completed examples.
  - Minimise unnecessary distractions and focus student attention on key ideas.

Sequencing the curriculum: An example from chemistry

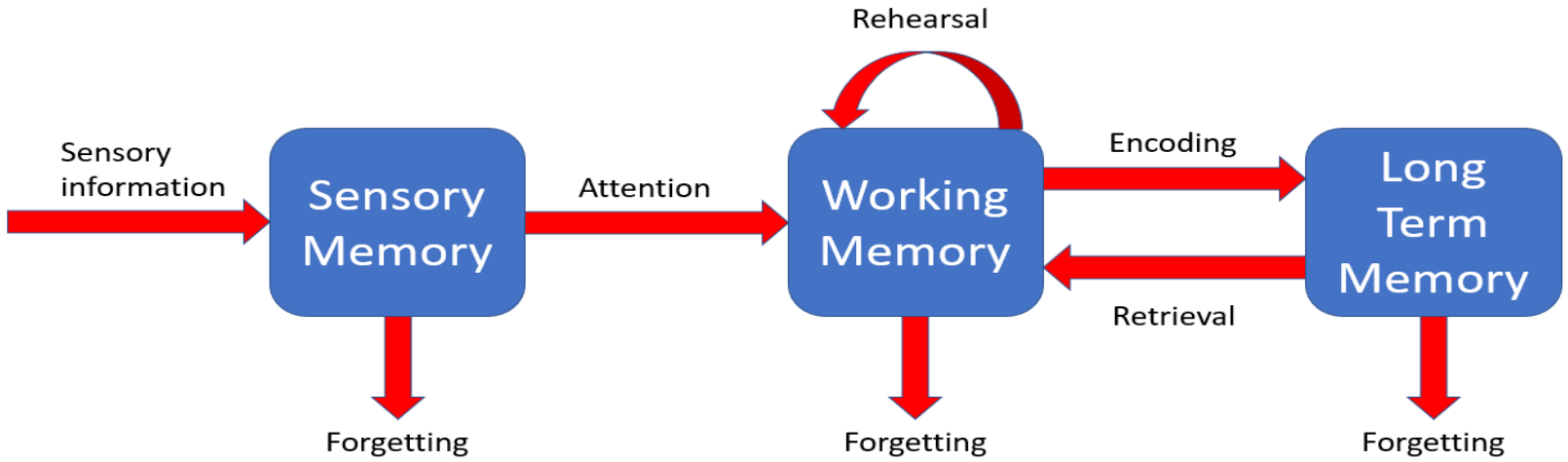
RSC England curriculum map

https://www.stem.org.uk/secondary/resources/collections/science/best-evidence-science-teaching?gclid=CjwKCAjwo9unBhBTEiwAipC118xYdV3KeUaw8b64jx_hAWoKqSk7MkEPt6DsVx6UF8DdSJ8ShVfazBoC_DMQAvD_BwE

Sequencing the curriculum is important!



Atkinson–Shiffrin memory model (1968) / Baddeley (1992) for WM rather than STM



Information passes sequentially through these stores - sensory input enters sensory memory; attention moves some of this to STM, where rehearsal is needed for retention; further rehearsal and encoding enable transfer to LTM.

Baddeley argued STM is not a single store, but a dynamic working memory system involved in processing and manipulating information, not just storing it.

Atkinson–Shiffrin memory model (1968) / Baddeley (1992) for WM rather than STM

Example – Matter and the particle model

At the start of a new topic, you give a KS3 class this task:

Explain the difference between boiling and evaporation. Use particle diagrams to support your explanation.

Try this task yourself and think about what the pupils might experience.

How could you use working memory and retrieval to support their learning?

Using retrieval practice – try this in groups

1. **Set up a retrieval task**
   Low-stakes quiz or write down everything you remember about evaporation and boiling.
2. **Gather and analyse responses**
   Highlight differences in answers, focus on misconceptions. Ask probing questions to understand pupils' conceptual models.
3. **Respond to misconceptions**
   Use tools such as visual aids, model, demos, practicals, questioning, concept mapping to deliver targeted teaching that clarifies concepts and corrects misconceptions.
4. **Re-check**
   Use a follow-up retrieval activity to confirm conceptual understanding.

Summary

Boiling is a rapid, bubble-forming process that happens throughout the bulk of a liquid at a specific temperature. Evaporation is a slow, surface-only process that can happen at a wide range of temperatures, often without visible signs, and leads to gradual liquid loss.

Why this approach matters

Retrieval uncovers invisible thinking and prior knowledge gaps.

Action after retrieval (diagnosis and targeted teaching) is crucial for real learning gains.

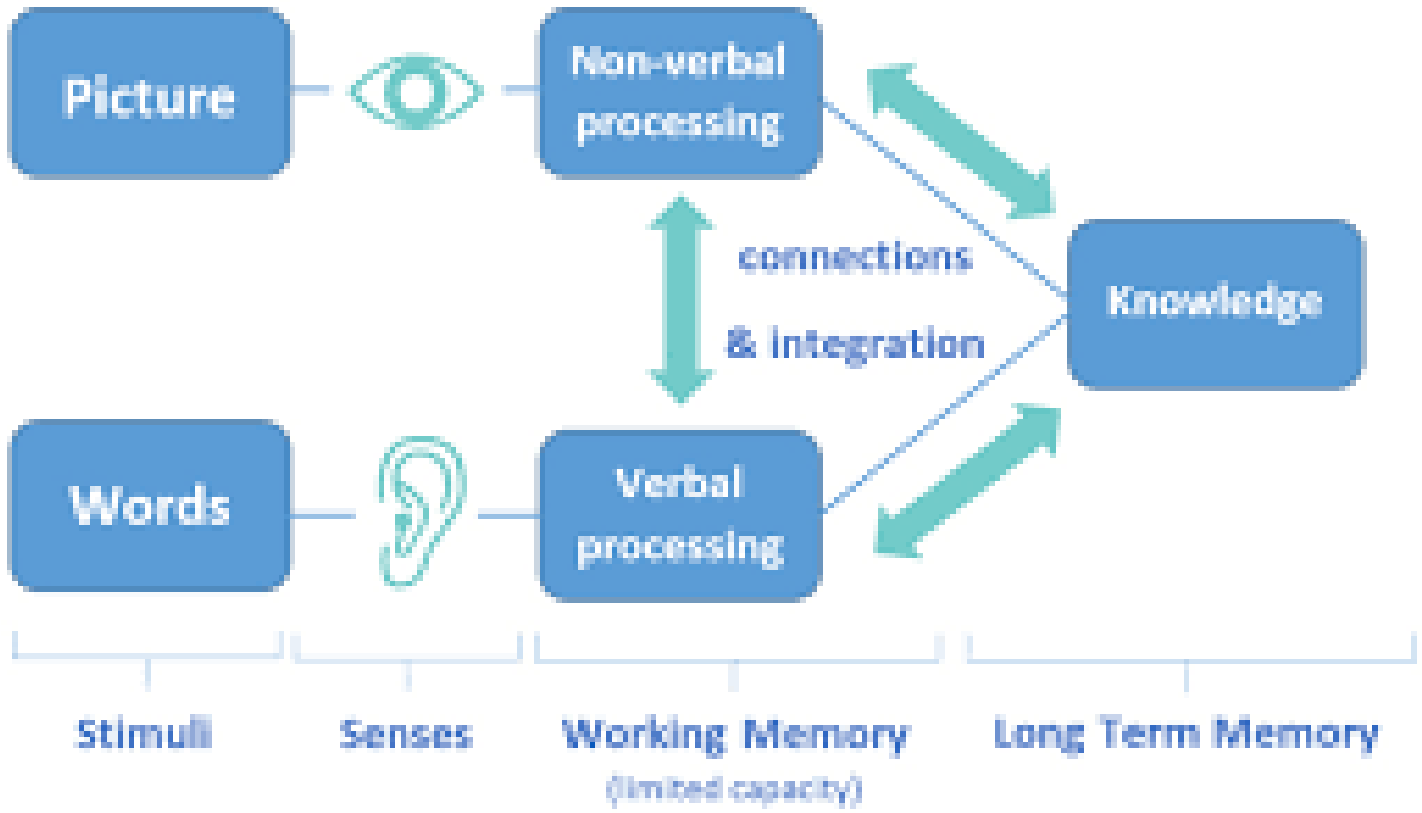
Retrieval, explanation, and revisiting ideas supports secure conceptual understanding, moving beyond memorisation.

Retrieval practice and progress

- Why retrieval works: Actively recalling information enhances long-term retention (the 'testing effect') and makes knowledge more accessible for new learning.
- Broader than quizzing: Retrieval should be planned to target important knowledge and misconceptions - not just quiz-style questions, but also activities like structured discussion or conceptual explanation.
- Supports all learners: Retrieval practice benefits all students, including those with lower working memory capacity, particularly when combined with feedback.
- Promotes progress: Retrieval helps identify learning gaps and common misunderstandings, so instruction can be adjusted to address them early.

Dual Coding Pavio and Clark (2006)

Two cognitive channels. Verbal and non-verbal. Can work independently and interconnectedly. Verbal and visual together is more likely to be remembered.



Which diagram would be most helpful for pupils?

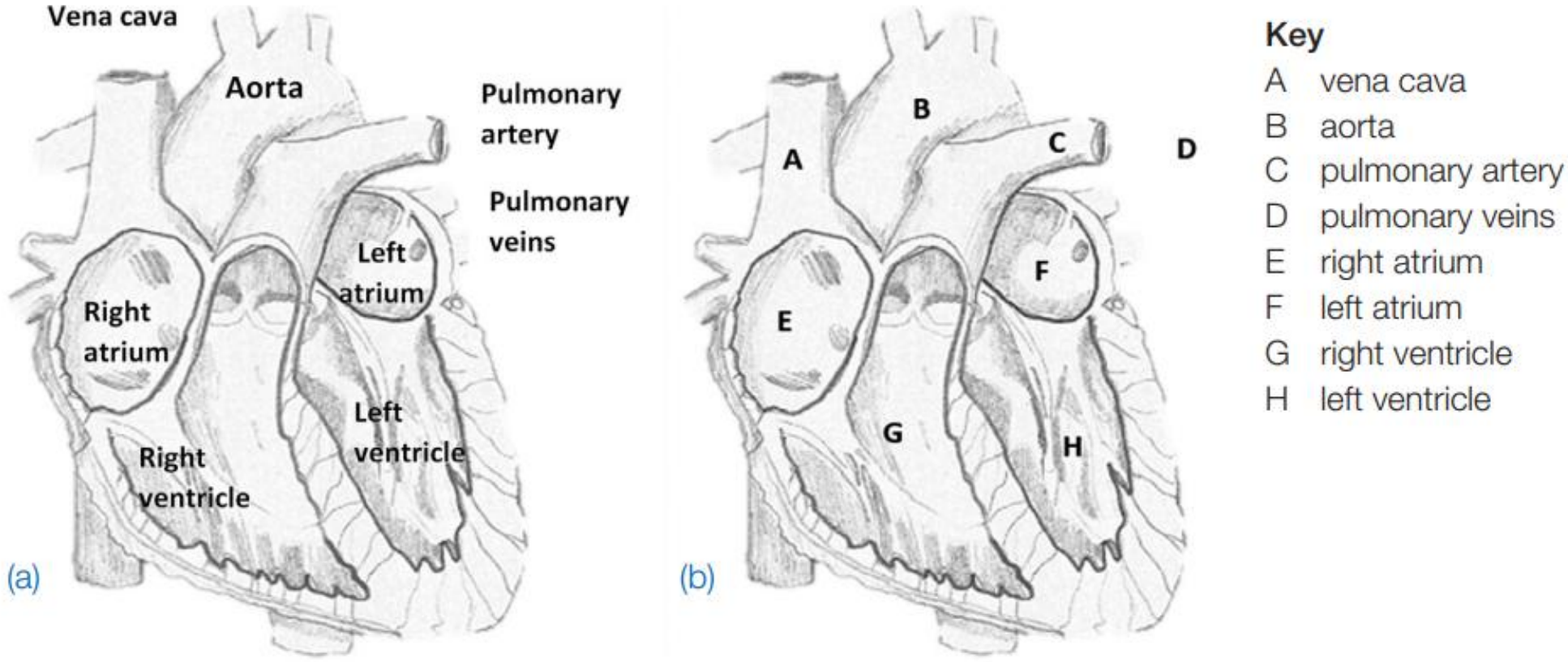


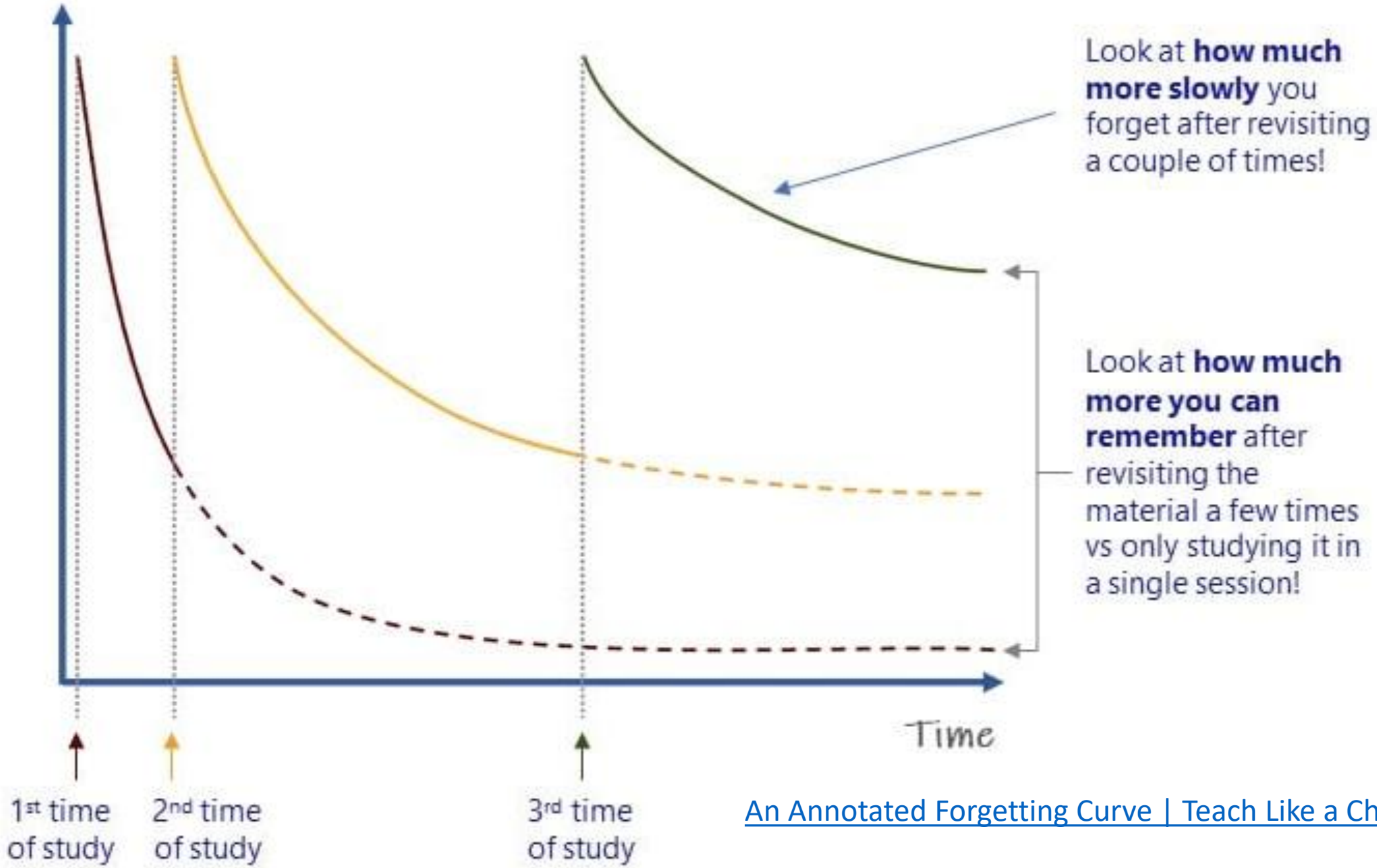
Figure 2 The spatial contiguity principle: (a) reducing extraneous load by integrating labels with visualisation; (b) extraneous load is increased when labels are not integrated with visualisation

Rebecca Torrance Jenkins, *Using educational neuroscience and psychology to teach science Part 1*. **SSR December 2017**

Split attention effect

A cognitive phenomenon in which learning is impaired because a learner must **divide attention** between two or more related sources of information that are separated in space or time - such as a diagram and accompanying explanatory text presented in different locations.

Students learn much better if labels are placed **directly on diagrams** (integrated), rather than requiring them to keep looking back and forth between a diagram and a separate list of names or explanations (split).



[An Annotated Forgetting Curve | Teach Like a Champion]

[Replication and Analysis of Ebbinghaus' Forgetting Curve - PMC]

Encourage retention and deep learning

- Balance and spacing: Use a mix of explanation, repetition, retrieval, and practice rather than isolated review sessions.
- Regular review: Plan for the regular revisiting of key concepts and encourage connections between prior and new learning.
- Address misconceptions: Proactively seek out and clarify students' misunderstandings as part of retrieval practice and formative assessment.

Practical classroom implications

- Sequence lessons to secure foundational knowledge before introducing complex content.
- Encourage pupils to articulate their current understanding and uncertainties to make gaps visible for corrective feedback.
- Use retrieval practice purposefully at different lesson stages to lighten cognitive load and reinforce key facts and ideas.

Core Research Articles & Frameworks

- Atkinson, R.C., & Shiffrin, R.M. (1968). Human Memory: A Proposed System and its Control Processes. In K.W. Spence & J.T. Spence (Eds.), *The Psychology of Learning and Motivation* (Vol. 2, pp. 47-89). New York: Academic Press.
- Baddeley, A.D. (1992). Working Memory. *Science*, 255(5044), 556–559.
- Clark, J.M. & Paivio, A. (2006). Dual Coding Theory and Education. In S. J. Tobias & F. Duffy (Eds.), *Handbook of Research on Educational Communications and Technology* (pp. 119-135). Routledge.
- Reid, N. (2009). Working memory and science education: conclusions and implications. *Research in Science & Technological Education*, 27(2), 245-250.
- Roediger, H.L., & Karpicke, J.D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17(3), 249–255. https://doi.org/10.1111/j.1467-9280.2006.01693.x

Policy & frameworks

- Department for Education. (2024). *Initial Teacher Training and Early Career Framework*. [UK Government Publication]
- Education Endowment Foundation (EEF). EEF blog articles on retrieval practice and memory: *Why bother with retrieval?* (2024), *Refining retrieval practice* (2024), *Tackling Misconceptions in Science*.

Cognitive science and practical applications

- Mayer, R.E. (2014). *The Cambridge Handbook of Multimedia Learning* (2nd ed.). Cambridge: Cambridge University Press.
- Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive Load Theory*. Springer.
- Pryke, S. (2020). The use of Socrative in university social science teaching. *Learning and Teaching*, 13(1), 67–86.
- InnerDrive. (2024). The Split Attention Effect: A quick guide. https://www.innerdrive.co.uk/blog/the-split-attention-effect/

Classroom practice

- Chartered College of Teaching. (2025). Retrieval practice in a secondary science classroom.
- BBC Bitesize. (2024). Evaporation.
- Education Hub. (2019). The benefits of retrieval practice in learning.
- Teacher Toolkit. (2021). A Systematic Review of (Classroom) Retrieval Practice.